CONCEPTUAL FRAMEWORK FOR AN EPISODE OF REHABILITATIVE CARE AFTER HIP FRACTURE SURGERY

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ABSTRACT

Researchers face a challenge when evaluating the effectiveness of rehabilitation after hip fracture surgery. Reported outcomes of rehabilitation will vary depending on the endpoint of the episode of care. Evaluation at an inappropriate endpoint may suggest a lack of effectiveness leading to the underuse of rehabilitation that could improve outcomes. The purpose of this paper is to describe a conceptual framework for a continuum-care-episode of rehabilitation after hip fracture surgery. We propose definitions for the index event, endpoint, and service scope of the episode. We discuss challenges in defining the episode of care, operationalizing the episode, and next steps for researchers. The episode described is intended to apply to all patients eligible for entry to rehabilitation after hip fracture and includes most functional recovery endpoints. This framework will provide a guide for rehabilitation researchers when designing and interpreting evaluations of the effectiveness of rehabilitation after hip fracture. Evaluation of all potential care episodes facilitates transparency in reporting of outcomes enabling researchers to determine the true effectiveness of rehabilitation after hip fracture surgery.

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1. BACKGROUND

1.1 Hip fracture and rehabilitation

A projected 4.5 million people will fracture their hip in 2050.[1] The injury has been dubbed the "hip attack" due to its clinical severity and adverse outcomes.[2] In spite of treatment, 30% of patients die within a year.[3] Among survivors, 25-50% need assistance in walking or never walk again, and 22% transition from independent living to long-term care.[4-6] These adverse outcomes reflect the interplay among characteristics of patients, their injury, and their access to medical care, surgery, and rehabilitation.[7,8]

Rehabilitation assists *'individuals who experience disability to achieve and maintain optimal functioning in interaction with their environment".*[9] Patients describe access to and delivery of rehabilitation as key to their ability to recover after hip fracture.[10-14] However, the most effective rehabilitation remains unclear.[15-22] This is evidenced by limited National Institute for Health and Care Excellence (NICE) guidance,[23] the absence of recent Cochrane systematic reviews, the conclusion of *insufficient evidence to recommend practice change* from earlier Cochrane reviews,[19-22] and the need for national audit of rehabilitation after hip fracture.[24] NICE and the authors of the Cochrane systematic reviews recommended research questions and priority areas for future research on rehabilitation after hip fracture (Table 1).

Table 1: National Institute for Health and Care Excellence and Cochrane systematic review authors recommended research questions and priority areas for future research on rehabilitation after hip fracture.

Source	Research Question/Priority Area
NICE 2017	*What is the clinical and cost effectiveness of additional intensive physiotherapy and/or occupational therapy (for example progressive resistance training) after hip fracture?*
NICE 2017	*Do patients admitted to hospital with a fractured hip who live permanently in a care/nursing home have equal access to multidisciplinary rehabilitation as patients admitted from their own homes?*
Smith et al 2015; Handoll et al 2011	*Identify the optimal model of rehabilitation after hip fracture to improve outcomes for patients with dementia.*

Handoll et al 2011	*Identify the optimal method to enhance long-term mobility after hip fracture.*
Handoll et al 2009; Handoll et al 2011	*Determine whether differing responses to rehabilitation occur among different subgroups of patients with hip fracture.*
Crotty et al 2010	*Identify the optimal timing, duration, setting, and administrating discipline(s) of rehabilitation after hip fracture across care settings.*
Handoll et al 2009	*Determine the effectiveness and cost effectiveness of multidisciplinary rehabilitation overall, rather than evaluate its component parts.*

1.2 Episode of care

There is currently no framework that specifies the appropriate start, duration, and endpoint of rehabilitation after hip fracture. Therefore, rehabilitation researchers face a challenge when designing and interpreting evaluations of the effectiveness of rehabilitation after hip fracture surgery. In particular, evaluation at an inappropriate time may suggest lack of effectiveness leading to the underuse of rehabilitation which could improve outcomes.[25]

Since the early 1960's, researchers have used *episodes of care* to identify and evaluate a set of services provided to treat a clinical condition.[26] This episode of care is often embedded in a broader *episode of illness* which may include multiple episodes of care as well as environmental and cultural dimensions of the illness.[25] Researchers must define three key elements when constructing an episode of care – the index event (start), scope of services and endpoint (acute- or continuum- care) (Table 2). These three elements are customized based on the nature of a health condition under examination and the aim of a research study.[25]

Table 2: Definition, purpose, and example of **hip fracture surgery** for terms used in the construction of episodes of care.

Term	Definition	Purpose	Example: hip fracture surgery
Episode of care	A set of health services provided to treat a clinical condition.[26]	To evaluate health services provided to treat a clinical condition.	Acute inpatient health care services following admission for hip fracture surgery.

Index event	The event that triggers the start of an episode of care.	To define the point from which services are considered by an evaluation. To identify the population for the evaluation.	Admission to acute inpatient care.
Endpoint	The event that triggers the end of an episode of care.	To define the point after which services are no longer considered by an evaluation. To define the point for measuring outcomes of the services.	Discharge from acute inpatient care.
Scope of services	Services considered part of treatment for a clinical condition.	The service scope will depend on the needs of individual patients, the exposure*-outcome relationship under evaluation, and available data.	Surgical repair of hip fracture completed during acute inpatient stay.
Episode of illness	Healthcare, environmental, and cultural dimensions of a clinical condition. May include multiple episodes of care.[25]	To describe the trajectory of health, environmental and cultural dimensions of a clinical condition.	Malnutrition.
Acute care episode	Tracks patients from acute inpatient admission to discharge.	To evaluate services received during acute inpatient stay.	Follows patients with hip fracture from acute inpatient admission to acute inpatient discharge.
Continuum care episode	Follows patients through an array of health services spanning different levels and intensity of care.	To evaluate all services related to the index event.	Follows patients with hip fracture from acute inpatient admission to post-acute services (e.g. until 6-week outpatient orthopaedic follow-up).

*intervention or independent variable of interest

In the current context, the episode of care reflects services related to rehabilitation after hip fracture surgery. Yet, there is no framework outlining an appropriate index event, scope of services, and endpoint of the episode of care. Previous studies of rehabilitation after hip

fracture surgery have predominantly adopted an acute-care episode using discharge from hospital as the episode endpoint.[21] This approach restricts outcomes to those that occur in-hospital, implying that rehabilitation ends at the point of discharge despite the fact that most patients go on to receive post-acute rehabilitation. Further, discharge from acute care **is** often driven by reducing acute length of hospital stay rather than rehabilitation outcome.[27] For these reasons, a continuum-care episode that follows patients through an array of health services spanning different levels and intensity of care ending with a rule or time window may be a more appropriate means to capture the true outcome of rehabilitation after hip fracture surgery. Continuum-care episodes have been successfully defined for other fields of specialist rehabilitation, for example, cardiac and stroke rehabilitation.[28,29]

Therefore, the purpose of this paper is to describe a conceptual framework for a continuum-care episode of rehabilitation after hip fracture. We propose definitions for the index event, service scope, and endpoint of the episode. This framework will provide a guide for researchers when designing and interpreting evaluations of the effectiveness of rehabilitation after hip fracture.

2. CONCEPTUAL FRAMEWORK

2.1 Index event

Surgery to repair hip fracture is the index event that triggers the start of the care episode (Figure 1). The selection of surgery as the index event, rather than the fracture itself, excludes between 2% and 6% of patients who do not undergo surgery after hip fracture.[30,31] In higher income countries, non-surgical patients are often non-ambulatory or deemed unfit for surgery.[32,33] These patients are often treated palliatively with a focus on quality of life and symptom control with different expected outcomes than patients treated surgically.[33,34]

2.2 Endpoint

The endpoint of a rehabilitation continuum-care-episode may be triggered by a decision rule, a predetermined time window, or a healthcare event.[25]

2.2.1 Decision rule

A logical episode endpoint is recovery from hip fracture. Recovery may be categorized as *from fracture*, or *functional*.[35] Recovery *from fracture* is achieved with fixation and bone healing, or arthroplasty.[36] *Functional recovery* is less clearly defined. Early studies described functional recovery in the context of survival whereby recovery is considered an alternative to death.[37] In this case *recovery from fracture* and *functional recovery* may be used interchangeably for an episode endpoint. However, ensuring survival to fracture repair is not the **only** important endpoint, especially for older adults who value the quality as well as quantity of survival time.[38] A similar construct was operationalized for quantifying the burden of disease in the form of the Disability-Adjusted Life Year (DALY) – the sum of years of life lost due to premature death and years of life lost due to disability.[39] In the current context, to ensure value from rehabilitation a functional recovery endpoint should reflect survival as well as additional dimensions of recovery.

Patients, caregivers, and therapists describe additional dimensions of functional recovery as *getting back to normal* or *back to baseline* (Figure 1).[40] Therapists often adopt a traditional biomedical model to define return to baseline as the attainment of prefracture physical dimensions of function (gait, balance, activities of daily living) (Figure 2). [35,41,42] Patients and caregivers adopt a more personal definition, which incorporates the importance to individuals of functioning well physically, instrumentally, cognitively, affectively and socially (Figure 2).[35,43,44] This is consistent with the World Health Organization (WHO) approach to healthy ageing as having the functional ability to be or to do what the individual

has reason to value.[45] Further, Griffiths et al. recently reported that patients with hip fracture considered functional recovery as "*stable mobility (without falls or fear of falls) for valued activities*".[44]

In current practice, patients often achieve a level of functional recovery better than simply avoiding death but not back to baseline.[4-6] It is not clear whether failure to attain baseline function is due to access and delivery of medical care, surgical care, and rehabilitation, or to characteristics of the patient and their injury.[8,46] *Back to baseline* may not be a feasible endpoint where characteristics of the patient and their injury limit recovery. Indeed, some patients report they do not expect to return to their baseline function.[43,47] In this case rehabilitation may be considered a re-adaptive process, where the patient adapts his/her set of values to a different, more restricted life situation – their new baseline.[48]

2.2.2 Time window

Completion of a predefined time window could trigger the end of a rehabilitation continuum-care-episode.

The time window may be defined as completion of a fixed period from the episode index event. This endpoint is commonly used for clinical and cost effectiveness evaluation that seeks to compare outcomes across locations that have different discharge practices.[25] However, the optimal duration of this period is unclear. In the US, a new episode of care, Surgical Hip and Femur Fracture Treatment Model, took effect in January 2018. Under this episode providers pay for acute inpatient hospital services and post-acute services within 90 days.[49] The 90-day window was selected after cost evaluation indicated "*significant services related to the clinical condition that is the focus of the model* [hip fracture] *occurred during days 31-90"*.[49] However, patterns of recovery vary by dimensions of functional recovery (physical, instrumental, cognitive, affective and social).[35] Recovery of most dimensions show

158 a lessening of dependence in the first 6-12 months.[35] Therefore, the UK's National Institute
159 for Health and Care Excellence (NICE) guideline and the Canadian National Hip Fracture
160 Toolkit support a longer window of 12-months suggesting that changes in health state after
161 12 months are no longer influenced by their hip fracture.[23,50]

162 The time window may also be defined as completion of a fixed period where no improvement
163 in patient function is observed. This endpoint is sometimes described as *reached recovery*
164 *potential* or a *plateau* in recovery. A US survey noted more than 50% of physiotherapists fail
165 to use standardized outcome measures to inform their care plan.[51] Therefore, for many
166 patients a plateau endpoint may be motivated by a therapist's previous experience or by finite
167 health care resources rather than an objective measure of recovery. [43,52-54] However, in non-
168 clinical populations, a performance plateau is not indicative of a lack of capacity for further
169 gain.[55] Indeed, an observed plateau may be a temporary cessation in recovery rather than an
170 outcome (Figure 3).[52] This plateau may be overcome by changes in the dose, timing, and
171 composition of rehabilitation which the therapist can offer.[52] For older adults, a plateau may
172 also reflect functional gains mitigated by declining function associated with other diseases or
173 ageing.[46] Therefore, termination of rehabilitation may lead to accelerated decline for these
174 patients. To minimize harm from potential underuse of rehabilitation, a follow-up
175 reassessment should be scheduled for patients whose episode is ended after failure to
176 overcome an objectively measured plateau despite changes in rehabilitation parameters.[28,29]

177 Alternatively, a time window may be defined by a clean period where no services related to
178 the episode are provided. This period may be defined by local protocol and is more consistent
179 with episodes for chronic conditions whereby patients enter symptom-free periods or periods
180 or remission.[25]

2.2.3 Healthcare events

A patient's death will trigger the end of a rehabilitation continuum-care-episode. Healthcare events which also trigger the end of a rehabilitation continuum-care-episode include a transfer to palliative care, readmission to hospital for complications, readmission for revision surgery, or the start of a new unrelated episode of care (Figure 1).[56] The assessment, treatment and management of these healthcare events is prioritized over rehabilitation after hip fracture. The patient may enter a new continuum-care-episode of rehabilitation following their healthcare event. The occurrence of a healthcare event may influence the change of functional recovery. Indeed, mortality is higher following second hip fracture.[56] Therefore, this episode should be defined by the healthcare event or as a subsequent rehabilitation episode.

2.3 Scope of Services

A Cochrane systematic review points to the need to evaluate all components of rehabilitation together rather than its component parts.[21] The continuum-care-episode of rehabilitation supports the inclusion of all relevant healthcare services following hip fracture surgery, which may be delivered across multiple care settings, and numerous individual providers. The specific scope of services, settings, and providers will depend on the exposure (intervention/independent variable) - outcome relationship under evaluation, available data, as well as the needs of individual patients as they relate to services.[25] Here we discuss acute and post-acute rehabilitation services as well as secondary prevention services delivered during rehabilitation.

Access to acute rehabilitation is more homogenous than other components of the rehabilitation care episode whereby all patients who undergo hip fracture surgery in higher income countries enter the rehabilitation service by default irrespective of treating country.

While most patients in high-income countries will receive early mobilisation and daily physiotherapy during their inpatient stay, [23,57] additional processes and duration of the service may vary. Indeed, the average postoperative acute length of stay was five days in the United States compared to 34 days in Japan.[58] The episode ends during acute rehabilitation only if a patient is transferred to palliative care, dies in hospital, or recovers their baseline function. Most patients' episode will progress to some form of post-acute rehabilitation services (Figure 4).

Access to post-acute rehabilitation is more heterogeneous whereby services and patients selected for entry vary by treating location. Evidence from the United States, England, and Canada suggests there is variation, even within a single health region, in the proportion of patients that are immediately discharged to each post-acute service such as inpatient rehabilitation, outpatient rehabilitation, home-based rehabilitation or long-term care rehabilitation (Figure 4).[59-63] Depending on their recovery status, patients may transition between several post-acute services as they progress towards the end of their continuum-care-episode of rehabilitation. In one Canadian province, Pitzul et al. noted 49 distinct post-acute patient pathways in the first year postfracture.[63] Moreover, these pathways are frequently changing in response to healthcare reform (e.g. restructuring of primary health care services[64]). The variation coupled with changing post-acute pathways present substantial challenges for researchers when attempting to evaluate the effectiveness of post-acute rehabilitation after hip fracture surgery.

Secondary prevention services are incorporated into the continuum-care-episode after hip fracture surgery. Processes of secondary prevention may begin within the acute care setting. Post-acute services may include fracture liaison services (services who case-find patients with fragility fractures at risk of osteoporosis and second hip fracture),[65-67] falls clinics,[68,69] or

the prescription of osteoporosis medication.[70] A truly comprehensive episode might even include services beyond those delivered by health-care providers. For example, it may be ideal to also include social care services which enable increased physical activity in the community.

3. DISCUSSION

3.1 Main findings

The extent to which outcomes of hip fracture surgery may be attributed to rehabilitation depends on the scope and endpoint of the episode. Here we describe a conceptual framework for constructing a rehabilitation continuum-care-episode. We identified surgery as the index event. We identified several independent potential endpoints. We suggest an episode endpoint of baseline, no improvement in recovery, 1-year postoperatively, or a healthcare event, whichever comes first (Figure 1). We suggest service scope should incorporate acute rehabilitation, post-acute rehabilitation, and secondary prevention.

3.2 Operationalizing the framework

The index event, service scope, and endpoints *time frame* and *healthcare event* may be operationalized using existing data sources (Table 3). For the additional endpoints *baseline* and *no improvement in recovery* proxy measures in existing data sources include return to preadmission residence and presence of a long-term follow-up reassessment respectively (Table 3).

Table 3: Element, conceptual and operational frameworks for episode of rehabilitation after hip fracture.

Element	Conceptual framework	Operational framework
Index event	Surgery for hip fracture	Procedure code for surgery after hip fracture
Endpoint	(i) Baseline	Return to preadmission residence (proxy)

		Need to identify core outcome set inclusive of patient reported outcome and experience measures
	(ii) Time frame	1 year after the procedure date
	(iii) No improvement in recovery	Presence of long-term follow-up reassessment (proxy)
		Need to determine duration of fixed period with no improvement in recovery after which to end the episode
	(iv) Healthcare event	Code for death, transfer to palliative care, or admission to acute care
Service scope	Acute and postacute rehabilitation, and secondary prevention	Unique patient identifier to link data from the index event acute hospital stay to postacute rehabilitation and secondary prevention services

We described the multifaceted nature of *back to baseline* as an episode endpoint. There is a need to determine how best to measure the physical, instrumental, cognitive, affective and social dimensions of this endpoint. There is no consensus on a core outcome set for evaluation of current and/or new interventions after hip fracture. In 2014, Haywood et al. recommended 5 core outcome measures for hip fracture trials - mortality, pain, activities of daily living, mobility, and quality of life as a minimum for all hip fracture trials.[71] They recommended single-item measures of mortality and mobility (indoor/outdoor walking status), and the EQ-5D.[71] This is less comprehensive than the 12 core outcomes for evaluation of orthogeriatric co-management for hip fractures (mortality, pain, activities of daily living (Barthel Index), mobility (Parker Mobility Score and the Timed Up and Go), quality of life, length of stay, time to surgery, complications, re-admission rate, medication use, place of residence, costs).[72] Consensus may lie somewhere between the two recommendations -to avoid burden of assessment while collecting sufficient data for evaluation. However, there is a need for consensus among rehabilitation researchers with respect to appropriate standardized outcome measures for activities of daily living and

mobility. Indeed, a recent randomized feasibility study of rehabilitation after hip fracture reported a ceiling effect for the Barthel Index.[73]

Further, it is difficult to objectively determine whether patients achieve 'back to baseline' as objective baseline measures are rarely available. Moreover, we highlighted *back to baseline* may not be a feasible endpoint for all patients after hip fracture. For those who do not achieve baseline status it is often not clear whether this relates to characteristics of the patient or the clinical effectiveness of rehabilitation. We suggest patient/caregiver reported outcome measures as well as patient/caregiver reported experience measures should be incorporated into the evaluation of rehabilitation after hip fracture surgery.[74] These measures will help to assess patients along two dimensions 1) satisfaction with outcome and rehabilitation experience and 2) more objective view on degree **of** returning to baseline status. We may cautiously interpret those who did not reach baseline status and were dissatisfied with their outcome due to receiving ineffective rehabilitation.

The endpoint *no improvement in recovery* presents even greater challenges. It is not clear whether it is feasible to define a fixed period after which to end an episode of care for rehabilitation after hip fracture for all patients. There is large heterogeneity in characteristics of the patient and their injury at baseline. This may lead to differing responses to rehabilitation among different subgroups of patients with hip fracture.[20,21]

3.3 Next steps

Since the early 1960's, researchers have used episodes of care to frame analyses of administrative and registry data.[26] External bodies standardize collection of these data which occurs at regular intervals. Researchers have no (or limited) control over which data is collected. Historically, most of these databases have not included data related to rehabilitation exposures and outcomes limiting their utility for rehabilitation research. Exposures focused

predominantly on structures such as composition of the multidisciplinary team and staffing levels, and outcomes included length of stay and discharge destination.[59,75] In 2010 Porter argued that "*achieving high value for patients must become the overarching goal of health care delivery*".[38] Since this time national registries have begun to incorporate rehabilitation process exposures such as timing of first mobilisation, and outcomes including the Cumulated Ambulation Score and the EQ-5D.[31,76] In 2018, a national audit of physiotherapy after hip fracture demonstrated variation in the frequency, type and duration of rehabilitation, as well as community waiting times and handover across services in the UK.[24] We anticipate an increase in the availability of rehabilitation process and outcome measures in administrative and registry data in the coming years.

This paper represents a step to prepare researchers for future evaluations of these data. It also provides clinicians with an understanding of the implications of framework selection for interpreting evaluation of these data. If operationalized, the care episode will enable evaluation of the effectiveness of rehabilitation after hip fracture surgery across the continuum care episode. Finally, the framework will help rehabilitation researchers to better design and implement evaluations to address evidence gaps highlighted by NICE and Cochrane systematic reviews.[19-23]

The framework focuses on the endpoint of a rehabilitation continuum-care episode. It does not include interim endpoints during this episode i.e. endpoints for acute care, inpatient rehabilitation, long-term care, outpatient or home-based rehabilitation. Further, the focus of the episode is functional recovery. However, other outcomes beyond this episode endpoint such as immobility related complications are also important. Optimizing these outcomes often require interplay between rehabilitation and environmental interventions.

4. CONCLUSION

To conclude, we constructed a continuum-care episode to guide rehabilitation researchers when designing and interpreting evaluations of rehabilitation after hip fracture. The episode described includes all patients eligible for entry to rehabilitation after hip fracture and **most** functional recovery endpoints. Evaluation of all potential care episodes facilitates transparency in reporting of outcomes enabling researchers to determine the true effectiveness of rehabilitation after hip fracture surgery.

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FIGURE LEGENDS

Figure 1: Conceptual framework for rehabilitation *continuum-care-episode* after hip fracture surgery.

* readmission for complications, readmission for revision surgery, or the start of a new unrelated episode of care.

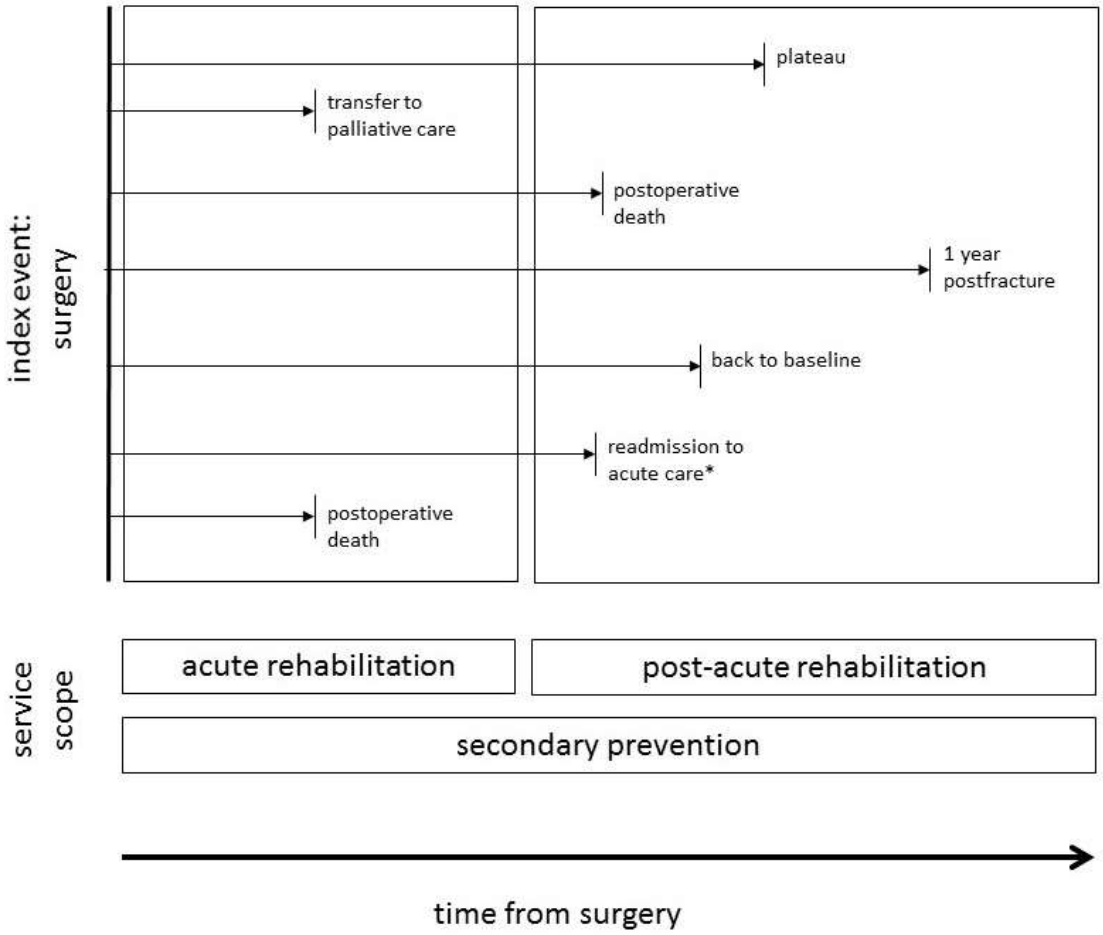
Figure 2: Defining back to baseline from patient and caregiver, and therapist perspective.

Figure 3: Plateau as an episode endpoint.

Figure 4: Expanded service scope of conceptual framework for *continuum-care* episode of rehabilitation after hip fracture surgery.

536 **FIGURES**

537 Figure 1



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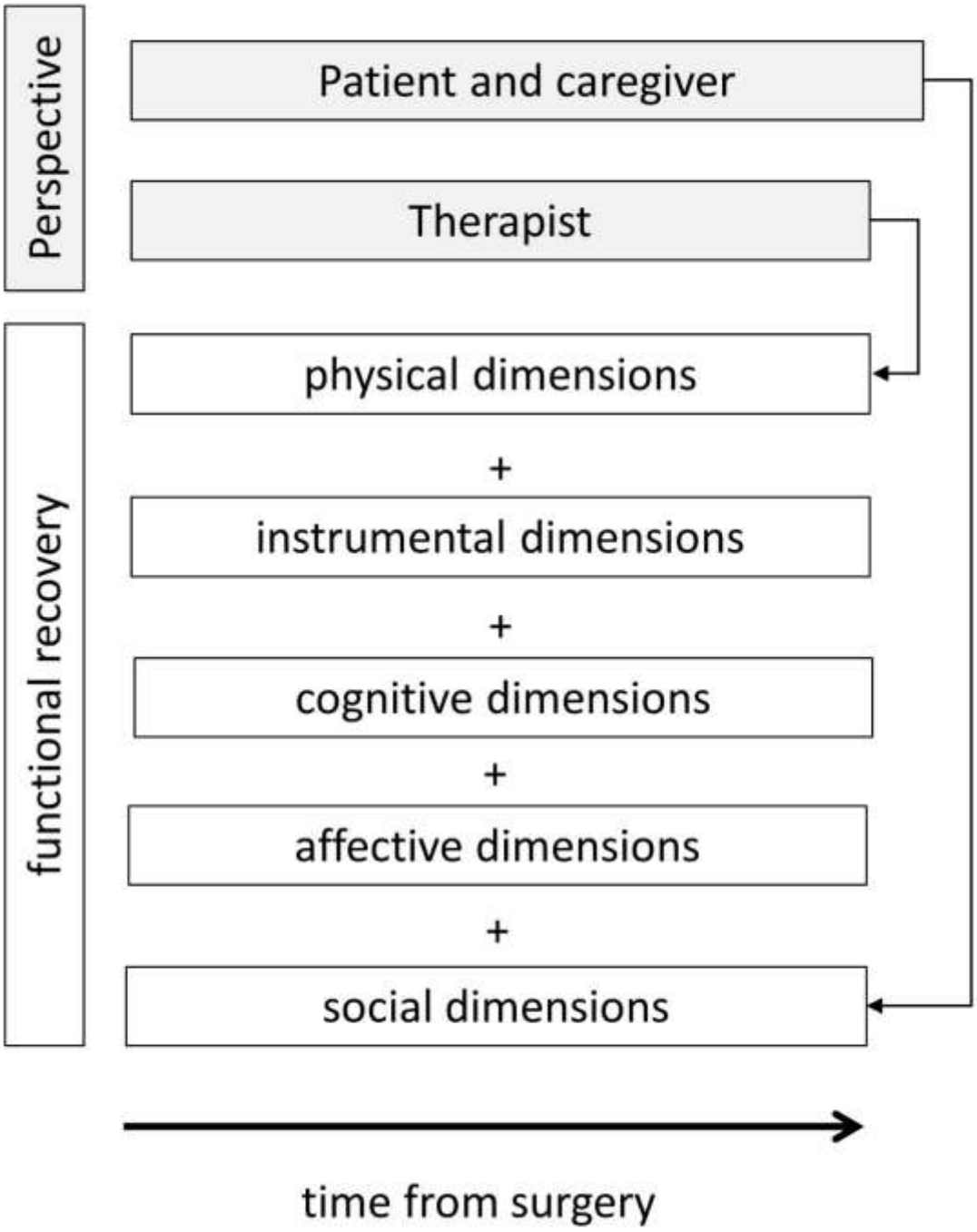
539 Figure 2



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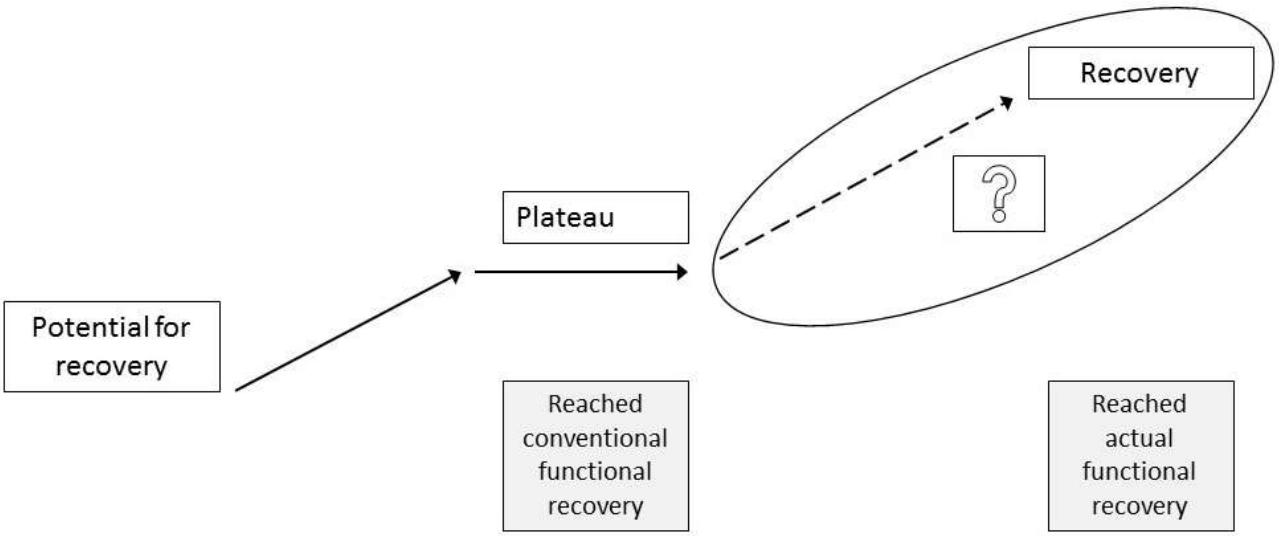
541 Figure 3



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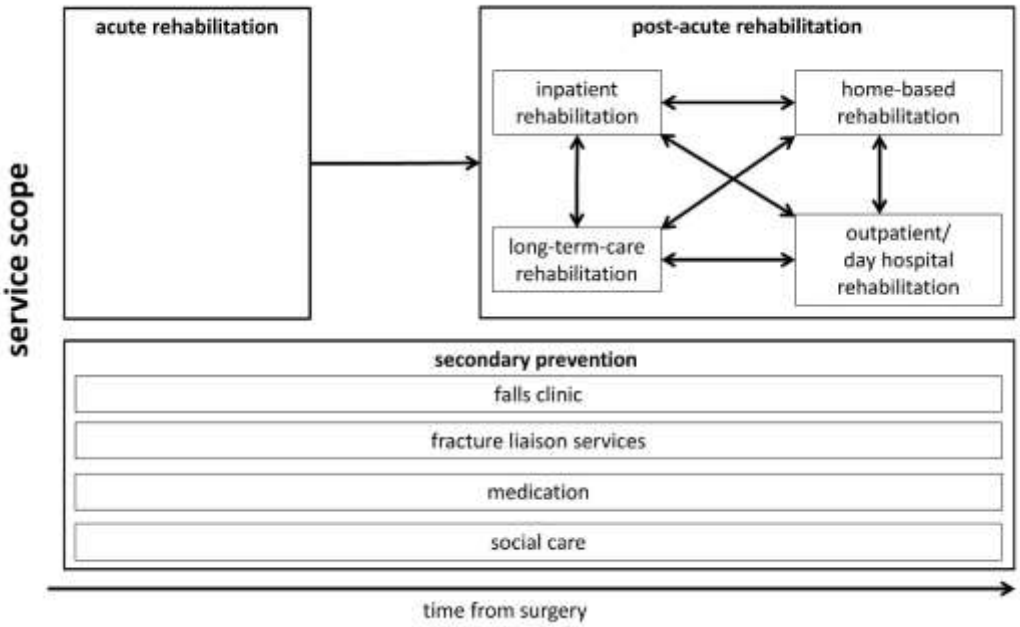
543 Figure 4



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